Nutritional Metrology Lectures
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Lecture - 12

Economic significance of nutritional investigations; some examples
Alleviating Micronutrient Malnutrition: what works?

- making the right food choice
- support programmes (e.g. consumer awareness)
- scientific and technical issues (safety/quality)
- cost-effective technologies to fortify commonly eaten foods
- nutritional enhancement of staple foods
- effective programming to identify bioavailable nutrient forms
- nutrient surveillance programmes to assure nutritional safety of fortified foods
Costs of micronutrient deficiency: 2 approaches

- Human costs (global burden of disease)
- Cost-effectiveness of interventions
- Favored by WHO (e.g. CHOICE: CHOosing Interventions which are Cost-Effective)

- Economic costs (health care, workloss)
- Cost-benefit of interventions
- Used by development Banks
Adult productivity losses: examples

- Iron deficiency anemia → lower maximal work capacity → productivity loss (heavy labor)
- Iron deficiency anemia → lower endurance → productivity loss (light work)
- Zinc deficiency → shorter stature → lower productivity
Cognitive losses: examples

- Deficiency $\rightarrow$ cognitive losses $\rightarrow$ educational losses $\rightarrow$ productivity losses (iodine, iron, vit. B-12, poss. zinc)
- Deficiency $\rightarrow$ cognitive losses $\rightarrow$ productivity losses (iodine, iron, B-12, zinc)
- Deficiency $\rightarrow$ morbidity $\rightarrow$ missed school $\rightarrow$ lost productivity (vit A)
Economic impact of folate supplementation

- 30% ↓ heart defects (recall data, periconception)
- 36% ↓ limb defects (same)
- 65% ↓ oral clefts in high-risk families (intervention/control)
- 50% ↓ spina bifida
- 22-40% ↓ in CHD mortality potentially
Economic impact of iodine deficiency

- 3.4% of births to a mother with goitre have zero economic productivity (cretins)
- 10.2% of births to a mother with goitre have 25% loss of economic productivity
- Remainder have 5% lower productivity (IQ is 13.5 points lower)
- Overall loss 15% per birth to a mother with goitre
- Doesn’t include stillbirths, other losses
Economic impact of iron supplementation

• 17% improvement in productivity in heavy manual labour
• 5% improvement in productivity in light manual labour
• 2.5% estimated improvement in other labour (cognitive effects); doesn’t include effects via schooling
Some perceptions on food fortification

• Universal flour fortification is a generic term
• Limited coverage of “target groups” such as pregnant women and young children
• No agreement on fortification levels for young children that are effective and safe
• Cost of effective surveillance system not accounted in the direct costs of fortification
• Despite accumulated evidence, convincing evidence still lacking on the effectiveness of flour fortification with iron (multiple contributing factors not addressed simultaneously making it ineffective in correcting iron deficiency).
Fortification of Foods with Micronutrients

• The FAO concept for sustainability of food fortification programmes: country driven rather than agency driven
• Past experiences: failure or inefficiencies of fortification programmes were due to the failure to address public concerns and to gain the widest public involvement
• Food fortification efforts need to be closely linked with nutrition education programme for the public
• Collaboration and coordination among governments, public, scientific and civic institutions, manufacturers and consumer groups
HARMONIZATION OF HEALTH RELATED ENVIRONMENTAL MEASUREMENTS USING NUCLEAR AND ISOTOPIC TECHNIQUES
Strategic Applications of Isotopic methods as diagnostic tools for nutrition monitoring

- Energy metabolism
- Body composition
- Lactation/infant growth
- Bone health (BMD)
- Food composition
- Food fortification
- Nutrient utilization
- Nutritional interventions
- Prevalence of infection
- Nutrition-pollution interactions

Nutritional Metrology as a factor affecting all of the above items: i.e. reliability of the analytical finding
Measuring iron bioavailability by isotopic techniques

The most common method is based on incorporation of the isotope e.g Fe-57, Fe-58 into red blood cells following extrinsic labeling (mixing label directly with the food) and feeding to the test subjects. Since newly absorbed iron is primarily used for hemoglobin synthesis, iron bioavailability from a specific diet can be determined by measuring the incorporation of an iron isotope into red blood cell hemoglobin 14 days after the ingestion of the test meal.
Indonesia: Evaluation of iron and zinc absorption from fortified foods

- 35% of pre-school age children underweight and 50% micronutrient deficient including iron & zinc
- 51% of pregnant women Iron deficiency anemia (IDA)
- The government decided to fortify wheat flour with Fe, Zn, folate
- The Agency’s technical support for bioavailability study as part of a traditional Indonesian diet.

Main outcomes:
1. The absorption of iron (iron sulfate) from fortified flour was high (15%)
2. Zinc sulfate reduced iron absorption from the fortified four (11%)
3. Zinc oxide does not affect iron absorption (14%)
CHILE: Fe and Zn studies in Chilean children

• Anemia (iron deficiency) prevalence in pre-school children was 30%.

• The National Supplementary Feeding Program covers 1.3 million people and costs US$300 million a year.

• A sample of 300 children within the program was additionally given milk fortified with iron and zinc.

• As a consequence, in these children anemia decreased to less than 8% after only one year.
Impact of iron fortified milk in infants: Evaluation of effectiveness in Chile

NSFP, Full fat powdered milk: 2 kg per month
Fortified with mg/100g
Iron (ferrous sulphate) 10
Ascorbic acid 70
Zinc (zinc sulphate) 5
Copper (copper sulphate) 0.5

14 infants 9-13 mo
Stable isotope study $^{57}\text{Fe},^{58}\text{Fe}$
Fe incorporation into RBC, TIMS

Iron bioavailability 10.5%
Iron supply (from 2 kg of milk)
0.8 mg/day absorbed

E. Hertrampf, INTA, U. de Chile/RLA/7/008
Conclusions & Implications: I

- Folate: losses in US (birth defects) exceeded $2bn annually (other losses in cvd)
- Iodine: worldwide economic losses (prior to salt iodization) could have exceeded $50bn annually
- Iron: losses in South Asia alone exceeded $5bn annually
Conclusions & Implications: II

• Iodine: appreciation of the economic case has helped motivate international action
• Iron: recent understanding of the economic case is helping motivate international action
• Folate: emerging economic data are helping motivate action in individual countries
Concluding remarks

“With adequate awareness to balanced nutrition and by choosing foods fortified at appropriate nutrient levels, consumers empower themselves to achieve their full social, physiological and economic potential.”

Kennedy, Mannar, Iyengar: IAEA Bulletin 45, 2003, pp.54-60
IAEA TECHNICAL COOPERATION REGIONAL PROJECT
Regional Latin America RLA/7/008 [1999-2002]
USING ISOTOPES TO EVALUATE NUTRITION INTERVENTION PROGRAMMES
OVERALL OBJECTIVE

Using validated isotopic techniques in the evaluation of current nutrition intervention programmes in Latin America, to optimise the programmes and to improve impact on the nutritional status and long-term health of the population.
SPECIFIC OBJECTIVES

TO EVALUATE

• The National supplementary feeding “take-home” programmes for mothers and children, measuring their effect on body composition.

• The iron and zinc supplementation programmes by using stables and radioactive isotopes

• The impact of food assistance to pre-school children attending day care centres by measuring energy intake, energy expenditure, and body composition.

DEVELOP/ENHANCE LOCAL CAPACITY
BUILDING TO WORK WITH STABLES ISOTOPES
PARTICIPATING COUNTRIES

BRAZIL
CHILE
CUBA
MEXICO

IAEA Resources spent so far (Dec 2002): US $1,162,350
PROGRAM EVALUATED IN BRAZIL

National Program for Food Assistance of Malnourished Children at Risk in the Northeast (cost US$ 110M)

IAEA PROJECT: Comparison between undernourished children in 10 municipalities in Northeast of Brazil reached by the milk distribution programme.
OBJECTIVES in BRAZIL

• Estimate effectiveness of the Programme on promoting child’s growth as assessed by anthropometry and body composition
• Measure maternal compliance to the recommended use of distributed supplement

Equipment and Subcontracts: 7 procurements orders
Training fellowship: 1 (one)
Scientific Output: results from this project served as basis for Dutch PhD
Publication: 1. The use of 2H2O for the assessment of milk intake and complementary feeding in breast-fed babies. A Wright, WA Coward (MRC Human Nutrition Research, Cambridge); H Haisma, E Albernaz, C Victora (Universidade Federal de Pelotas, Departamento de Medicina Social, Pelotas, RS, Brazil) submitted for publication.
PROGRAMS EVALUATED IN CHILE

Iron and Zinc Fortification of National Supplementary Feeding Program  
(cost US$ 100M)

and

Day-care Centers of National Board of Day-care and School Feeding Programs  
(cost US$ 200M)

IAEA Project: 1. O18 and deuterium studies for body composition and energy expenditure in Chilean children. 2. Fe and Zn bioavailability studies.
OBJECTIVES in CHILE

- Energy requirements, expenditure and intake, plus physical activity pattern of 3-5 year old children.
- Zn and Fe bioavailability of fortified milk and its impact on growth, body composition and anemia.

Equipment and Subcontracts:
40 procurements orders
Training fellowship: 1 (one)
Scientific Visits: 6 (six)
Experts Visits: 5 (five)
Specific outputs

Scientific Output: 3 Masters degrees and 1 PhD

Publications:

1. Equations for body composition assessment in Hispanic pre-school children. Its role in nutritional interventions to prevent obesity. MA Rocha, Hernandez J, I Perez, G Salazar. Institute of Nutrition and Food Technology, University of Chile, Santiago, Chile. IUNS 2001 abstracts

2. Body composition assessment in Chilean school children using isotopic methods. SP Guevara, N Diaz, J Hernandez, G Salazar. Institute of Nutrition and Food Technology, University of Chile, Santiago, Chile. IUNS 2001 abstracts

3. Energy Requirements of Pre-School Chilean Children. Implications for national policies. 1OL Cardona, G Salazar, E Diaz, M Andrade, J Hernandez, 2J Rojas. 1Institute of Nutrition and Food Technology, University of Chile and 2, National Council of Play Schools (JUNJI), Santiago, Chile. IUNS 2001 abstracts

4. Energy requirements in Chilean Infants. 1G Salazar, F Vio F, C García, E Aguirre, 2WA Coward. 1Institute of Nutrition and Food Technology, University of Chile, Santiago, Chile and 2MRC-HNR, Cambridge, United Kingdom. IUNS 2001 abstracts

5. Effects of iron supplement on zinc absorption in Chilean Women. M Ruz, J Codoceo, A Rebolledo, M Vasquez, NF Krebs, S Lei, JL Westcott, KM Hambidge. Department of Nutrition, Fac. Medicine, U. of Chile, Santiago, Chile, and Section of Nutrition Pediatrics, UCHSC, Denver, CO 80262. IUNS 2001 abstracts
Specific outputs

6. Iron bioavailability of complementary foods for young children provided by Chilean national supplementary program (NSFP). Hertrampf E, Olivares M, Pizarro F. Institute of Nutrition & Food Technology. University of Chile, Chile. IUNS 2001 abstracts

7. Maternal smoking effect on infant longitudinal growth. MR Berlanga1, G Salazar J Hernandez,, 2M Ruz M, F Vio. 1Institute of Nutrition and Food Technology (INTA), 2 Department of Nutrition, Faculty of Medicine, Universidad de Chile. IUNS 2001 abstracts


PROGRAMS EVALUATED IN CUBA

Day-care Centers of the National Program of Food and Nutrition
(cost US$ 80M)

IAEA Project: 1. Use of O18 and deuterium studies for energy requirements of preschool children. 2. Measurements of energy expenditure of children in different environmental conditions.
OBJECTIVES in CUBA

- The adequacy of the program to supply the energy requirements of pre-school children
- Measurements of energy expenditure according with their physical activity level and their environmental conditions

Equipment and Subcontracts:
- 26 procurements orders
- Training fellowship: 6 (six)
- Scientific Visits: 2 (two)
- Experts Visits: 5 (five)
Cuba outputs

Scientific Output/ Publications:


PROGRAMS EVALUATED IN MEXICO

Education, Health & Nutrition Program (PROGRESA)
(cost US$ 2B)

IAEA Project: 1. Impact evaluation of PROGRESA on energy expenditure and body composition in lactating women and preschool children. 2. Comparison of absorption of iron in the PROGRESA baby food supplement and zinc in the fortified corn flour tortillas to optimise its use.
OBJECTIVES in Mexico

- Impact of the food supplement (PROGRESSA) on the energy expenditure and body composition of lactating women and preschool age children
- Bioavailability of Fe and Zn in food supplement and in food fortification

Equipment and subcontracts:
- 26 procurements orders
- Training fellowship: 1 (one)
- Experts Visits: 4 (four)
RLA/7/008 OVERALL ACCOMPLISHMENTS (1)

• Increase awareness of the usefulness of stable isotopes in evaluation and optimization of nutrition programs in the Latin American Region

• Strong presence of IAEA supported work in International Nutrition Community e.g. IUNS-Vienna 2001

• Results from this RLA project in Cuba and Chile were used by FAO/WHO/UNU expert committee to establish new energy recommendations
RLA/7/008 OVERALL ACCOMPLISHMENTS (2)

• Modification of existing programs based on results from RLA projects:
  In Chile, the Energy balance data support need to reduce intake and increase activity to avoid obesity
  In Mexico, the negligible impact of supplement due to low Fe availability, thus a reformulation was needed
• Enhanced national capacity using nuclear techniques in nutrition
• Two Group training courses for the LA Region
**EXCEPTIONAL OUTCOME RLA/7/008**

- CHILE in particular has been a driving force for the success of RLA7/008
- CHILE has excellent scientific capabilities at INTA and it is in the position to serve as a REGIONAL RESOURCE CENTRE
- CHILE’s role as “experts” for LA region in future projects is the single most important outcome of this project.
Phasing of Micronutrient Interventions

Supplementation
Public Health Measures
Fortification
Dietary improvement

Relative contribution of interventions to eliminate MND

2000               2005               2010
Thank you!